5.3.4.1 Summary of Probing Activity at the Subsurface Disposal Area. From December 1999 to October 2001, more than 200 probes were installed in buried waste at the SDA. One hundred forty of these probes were installed in areas of pits known to contain 743-series waste, which is the source of VOCs. The number of different types of probes installed in VOC source areas and the dates they were installed are shown in Figure 5-15. The different types of probes include Type A (steel cased hole for nuclear logging), tensiometer, moisture, vapor sampling, lysimeter, and visual probes. The probes were installed using sonic push technology. Additional information on probe installations and activities is contained in INEEL/EXT-2000-00814 (INEEL 2002) and DOE/ID-10995.[c]

To examine the possibility of VOC releases caused by probing, information on probe installation dates were compared graphically to inlet concentrations. The data were examined even further by dividing the probe installations between those installed in 743-series waste-source areas (see Figure 5-1) and those installed in the 743 Focus Area. The 743 Focus Area is in the eastern end of Pit 10 where 743-series waste drums are the most highly concentrated. The 743 Focus Area is also the source area closest to Well 8901 and VVET Unit A. Figure 5-16 shows the location of probes installed in the 743 Focus Area, and Figure 5-17 shows the number of probes installed each day in the 743 Focus Area as well as those installed in the other 743 source areas.

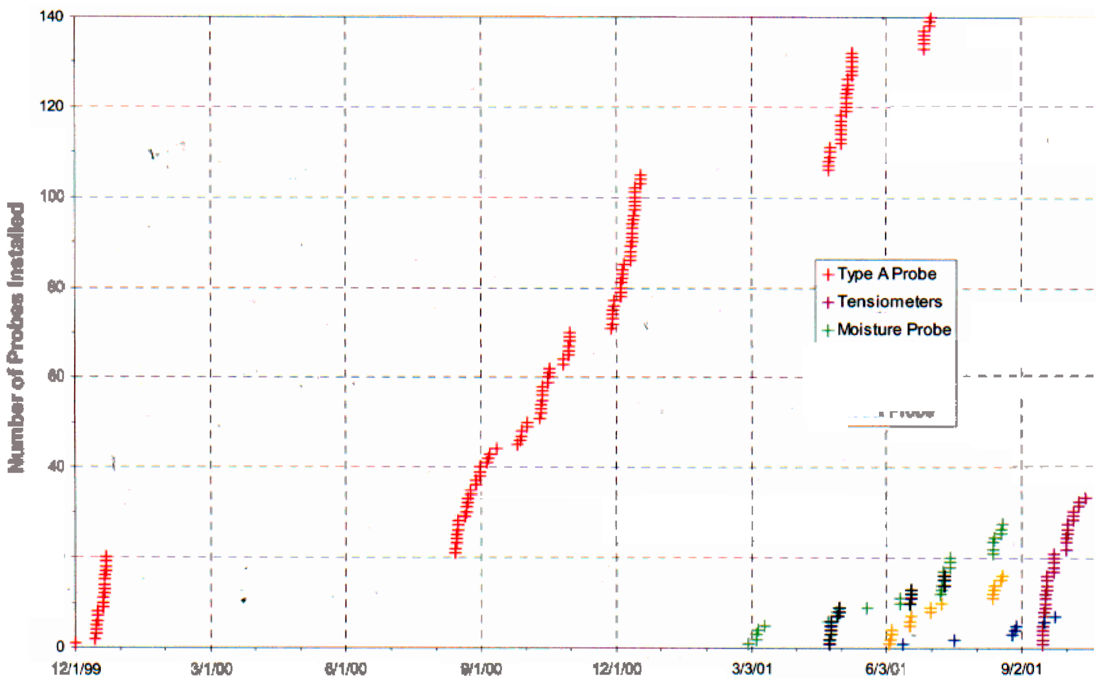

Figure 5-15. Probes installed in areas of 743-series waste at the Subsurface Disposal Area.

c. Holdren, K. Jean, Becker, Bruce H., Nancy L. Hampton, L. Don Koeppen, Swen O. Magnuson, T. J. Meyer, Gail L. Olson, and A. Jeffrey Sondrup, 2002, *Waste Area Group 7 Operable Unit 7-13/14 Pre-Draft Remedial Investigation and Baseline Risk Assessment (Draft)* DOE/ID-10995, Rev. C, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

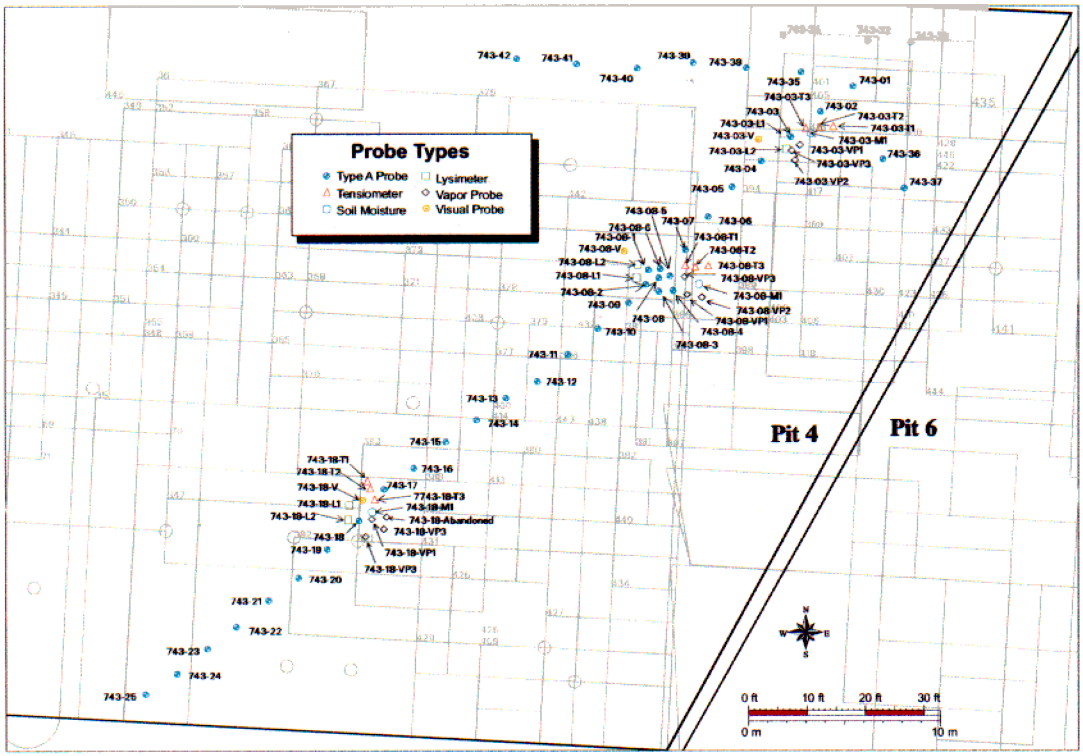

Figure 5-16. Probe locations in the 743 Focus Area at the Subsurface Disposal Area.

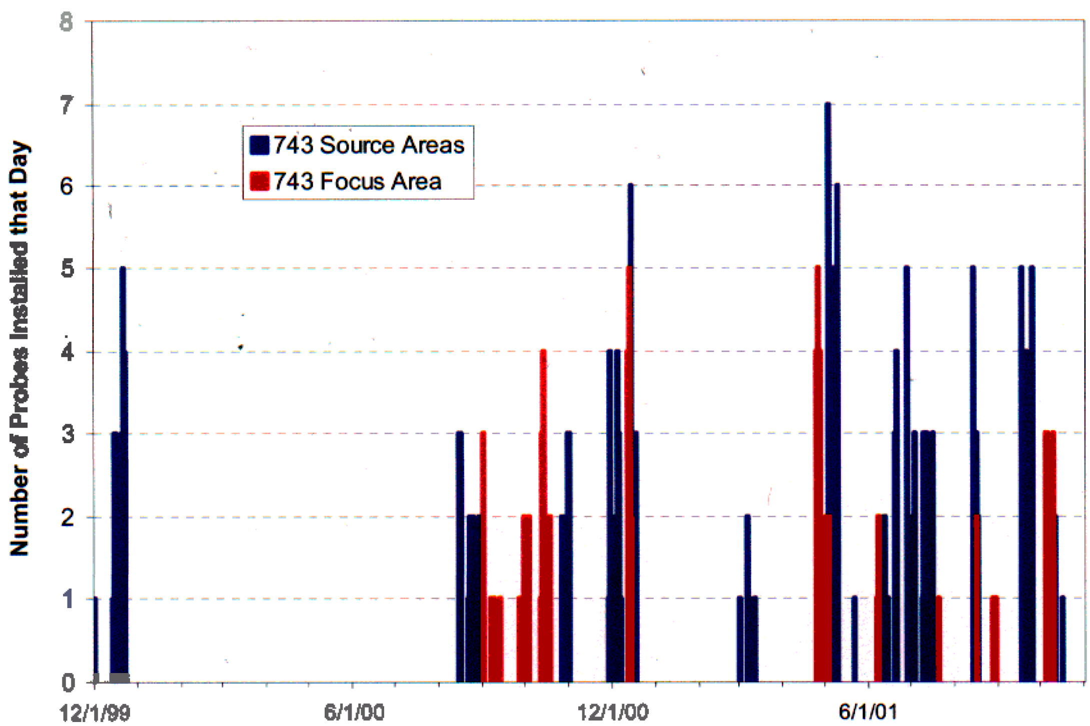

Figure 5-17. Probe installations each day in the 743 Focus Area and other 743 source areas (not including the 743 Focus Area).

In Figures 5-18, 5-19, and 5-20, the probe installation data shown in Figure 5-17 are added to the graphs of inlet concentration data for the respective VVET units. Figure 5-18 shows that the probe installations in 2000 coincide with the rise in inlet concentration even with Unit A operating. Volatile organic compound concentrations in air, measured with an open path Fourier transform infrared spectrometry instrument, also show spikes during this time (Harvego 2002). However, the inlet concentration is decreasing during the time when the 2001 probe installations were completed. This does not rule out probing as the cause because there may be other influences such as seasonal infiltration that could lessen the impact of probing. It could also be that the 2000-probing hit VOC waste while the 2001-probing did not. In Figure 5-19 that shows Unit B inlet concentrations, it is difficult to determine if probing caused an increase in inlet concentrations since Unit B was not operating when probes were installed. However, inlet concentrations did increase substantially over the shutdown period. In Figure 5-20 that shows Unit C inlet concentrations, it appears that probing had little effect, if any, on inlet concentrations to Unit C. This may be because fewer probes were installed in the areas around Unit C, and the 743-series waste is not as dense in this area.

While it is not conclusive, it does appear that probing may have accelerated VOC releases from remaining VOC waste, which consequently led to higher subsurface and inlet concentrations to Units A and B. It is recommended that this be examined further by a more complete analysis of the existing data, including correlation of gas monitoring data and open path Fourier transform infrared spectrometry monitoring and by opportunistic monitoring and sampling during any subsequent probe installation or waste excavation activities. The knowledge that probing may or may not accelerate VOC release is worth pursuing for several reasons. First, it may help explain uncharacteristic trends in subsurface vapor concentration data coincident with probing. It will also help validate or refute the assumption that additional source remains in the pits. While it won't quantitatively determine the source mass, it will give a general indication of the amount. This information would be valuable to OU 7-08 for making operational decisions. For example, if the remaining source mass is substantial as is currently believed, enhancing release through some type of probing or source disruption could lessen the operational time of OU 7-08.

5.3.5 Vapor Port Volatile Organic Compound Concentrations

Most of the subsurface vapor ports in and around the SDA (see Figure 5-3) are monitored on a regular (usually monthly) basis. In this section, carbon tetrachloride concentrations from several ports have been combined with VVET inlet concentration data to provide a mechanism for interrogation of the extent of influence of each of the extraction wells. Not all the vapor port data are presented here. Only data from those wells and ports that showed a high degree of correlation with unit operation, inlet concentration, probe installation, or some other influence were presented. To help assess probing impacts on VOC concentration, the probe installation data shown in Figure 5-17 have been added to some of the figures.

5.3.5.1 Unit A. Figures 5-21–5-29 show the concentrations measured at select vapor ports combined with the operational history of Unit A and the Unit A inlet concentration data. Table 5-3 contains the depth of the vapor ports and approximate distance from Well 8901. Well locations are shown in Figure 5-3. As previously noted, Well 8901 is the primary extraction well for Unit A. Though Well 8901 has always been connected to Unit A, Well 4E was also connected to Unit A from January 1996 to September 1997, but it is believed that most of the flow came from Well 8901. The screened section of Well 4E was completed in a low-permeability material, and the screen became plugged with a microbial growth. After Well 4E was disconnected, Well 7V was connected to Unit A from September 1997 until September 1999 while Unit C was being rebuilt.

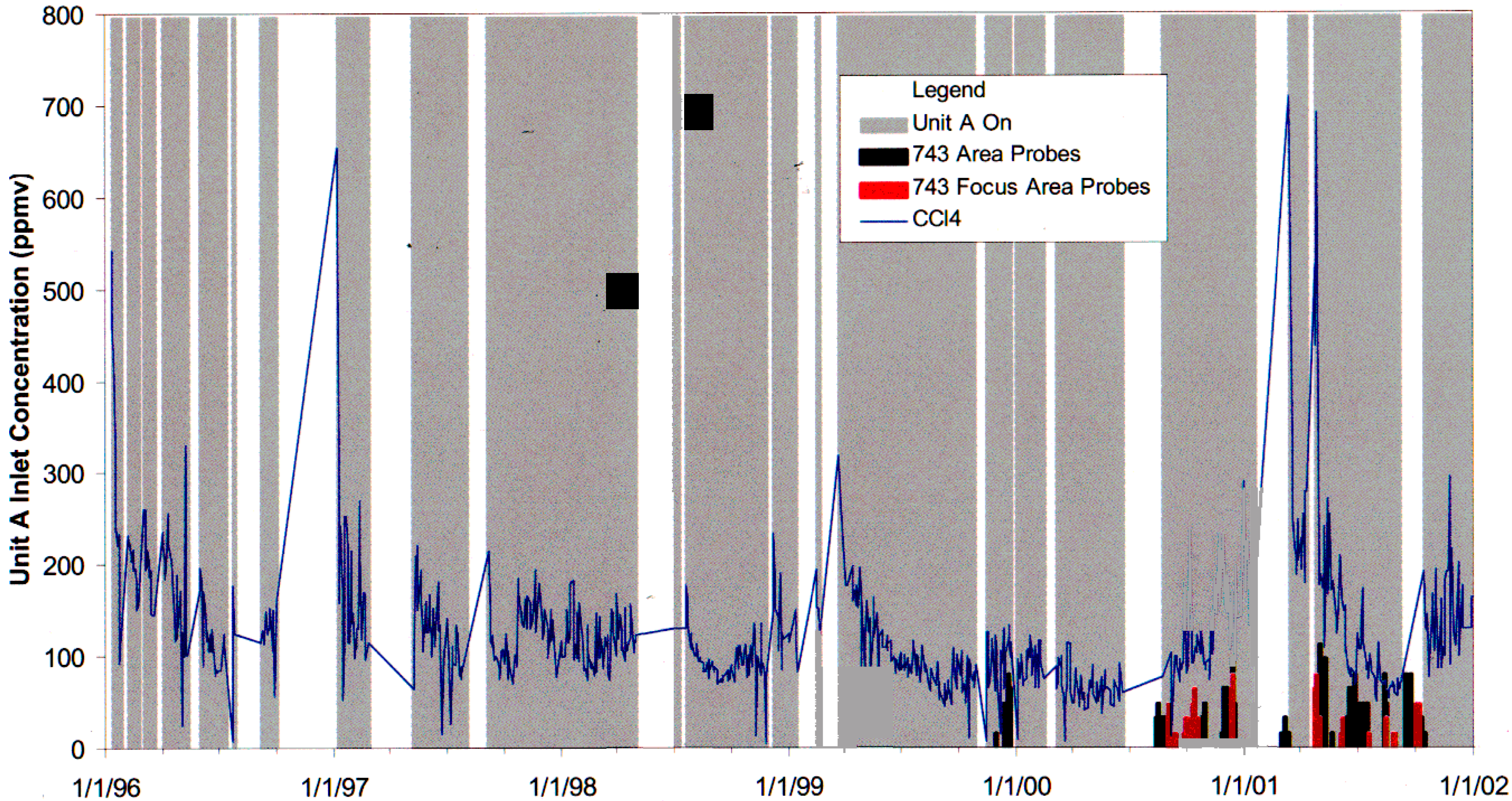

Figure 5-18. Unit A operating history and inlet carbon tetrachloride concentration with probe installation data.

Note: See Figure 5-17 for explanation of probe installation data.

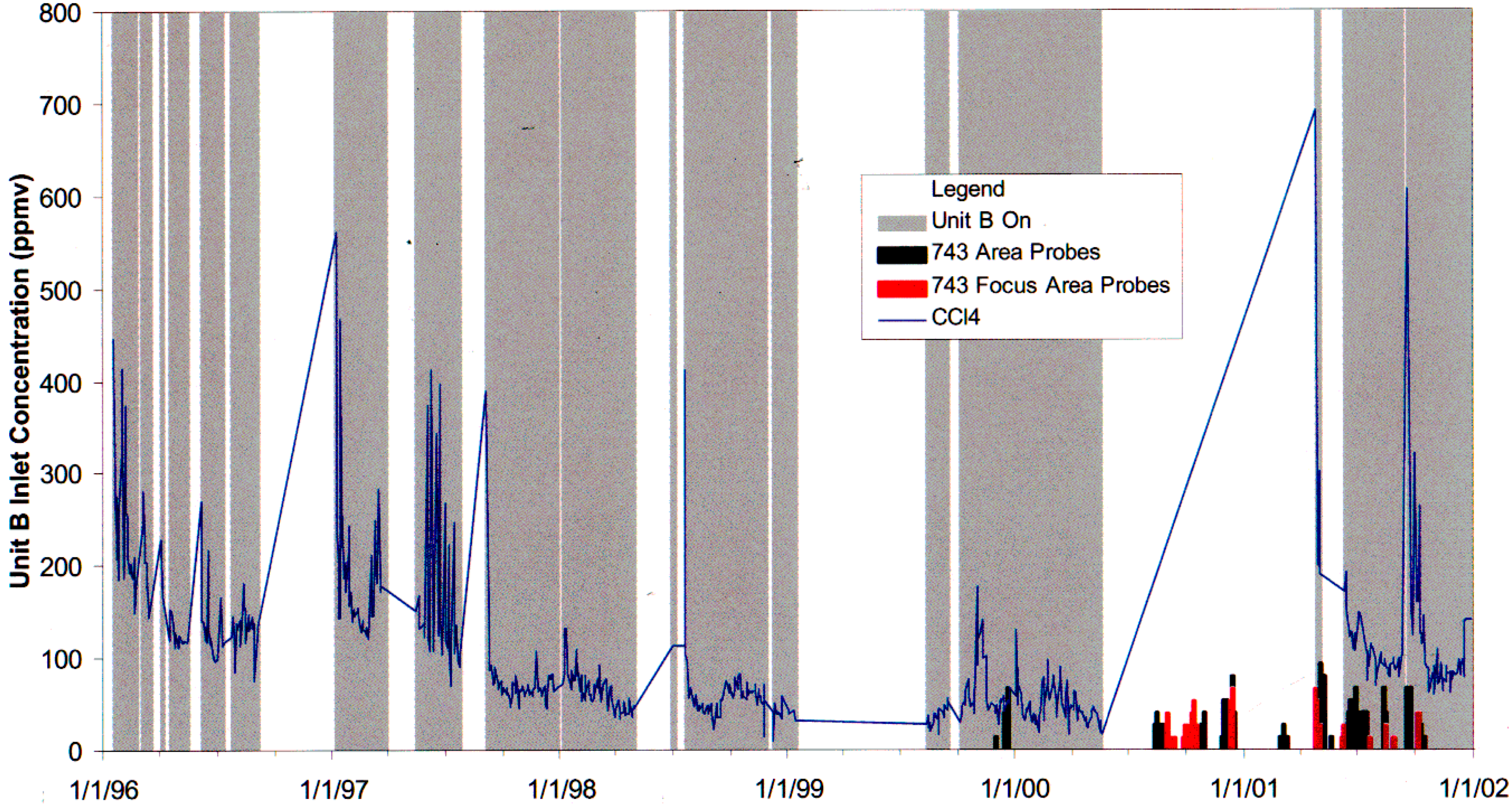

Figure 5-19. Unit B operating history and inlet carbon tetrachloride concentration with probe installation data.

Note: See Figure 5-17 for explanation of probe installation data.

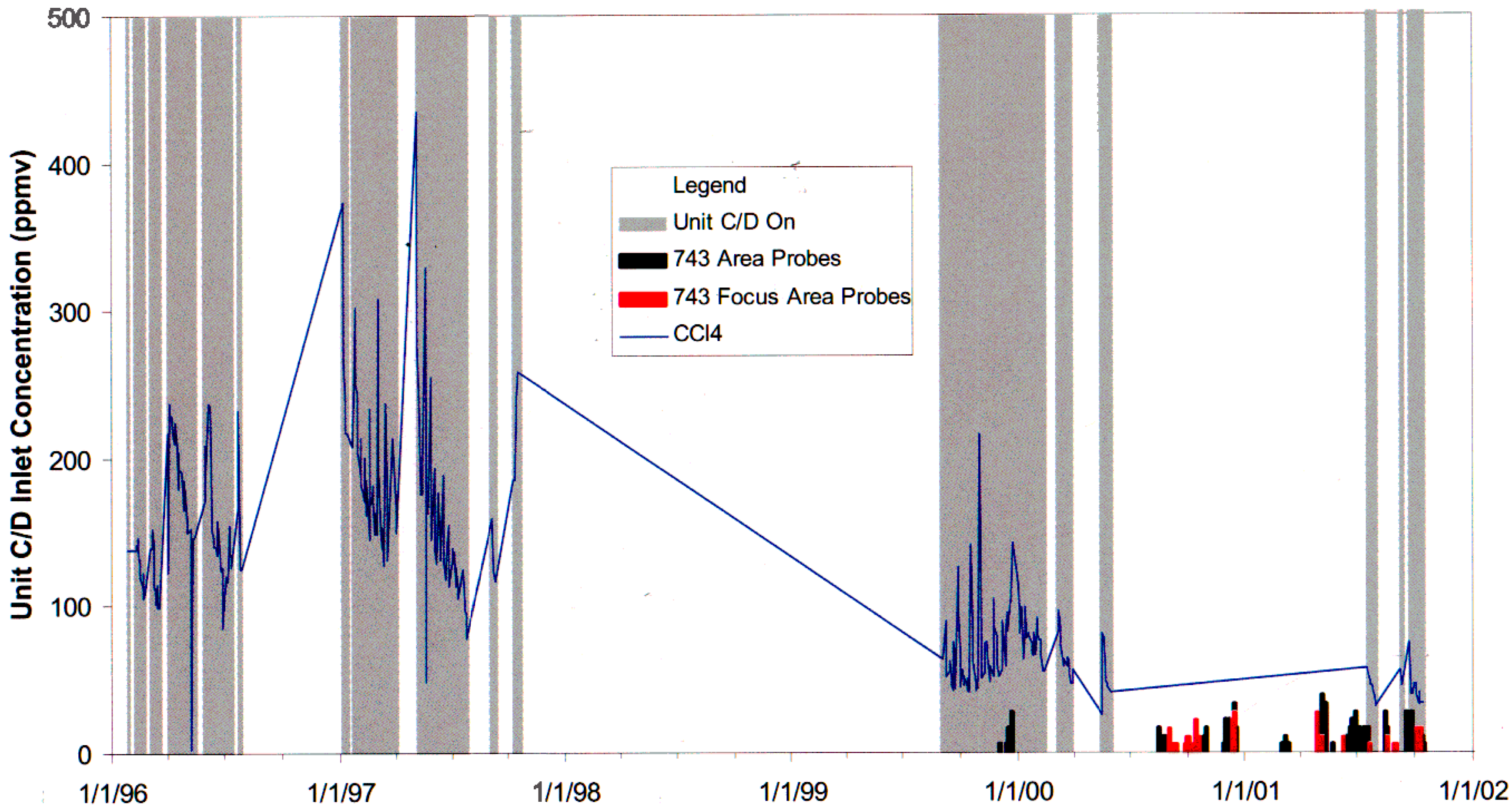

Figure 5-20. Units C and D operating history and inlet carbon tetrachloride concentration with probe installation data.

Note: See Figure 5-17 for explanation of probe installation data.

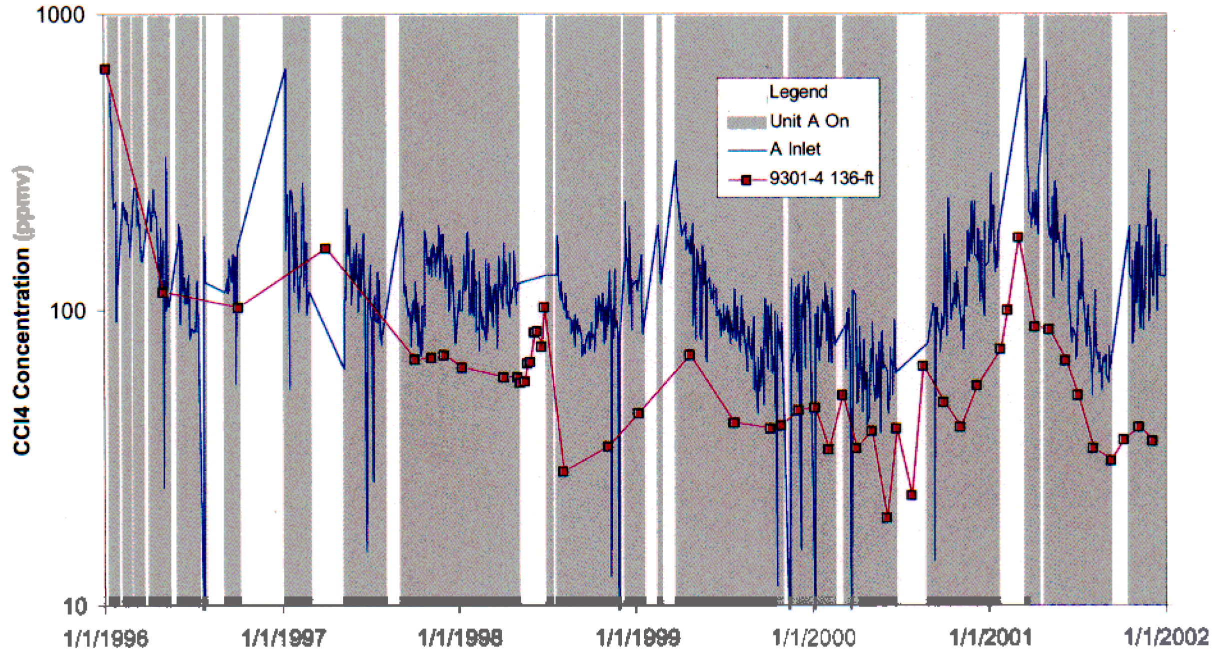

Figure 5-21. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 9301-4.

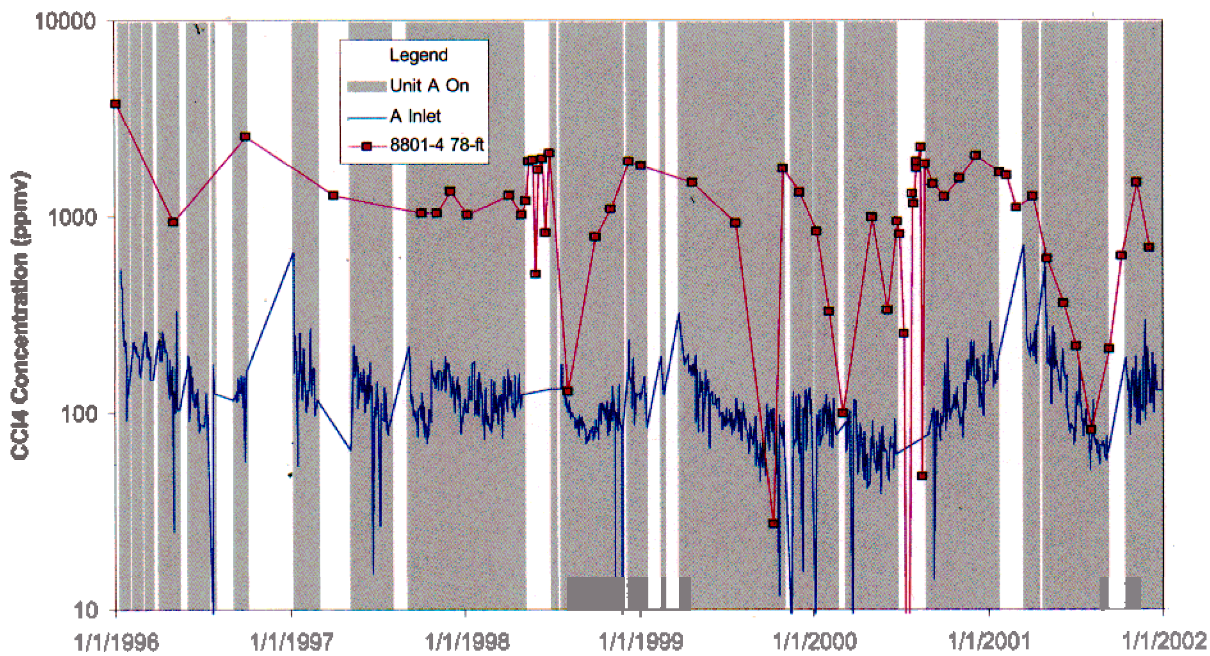

Figure 5-22. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 8801-4.

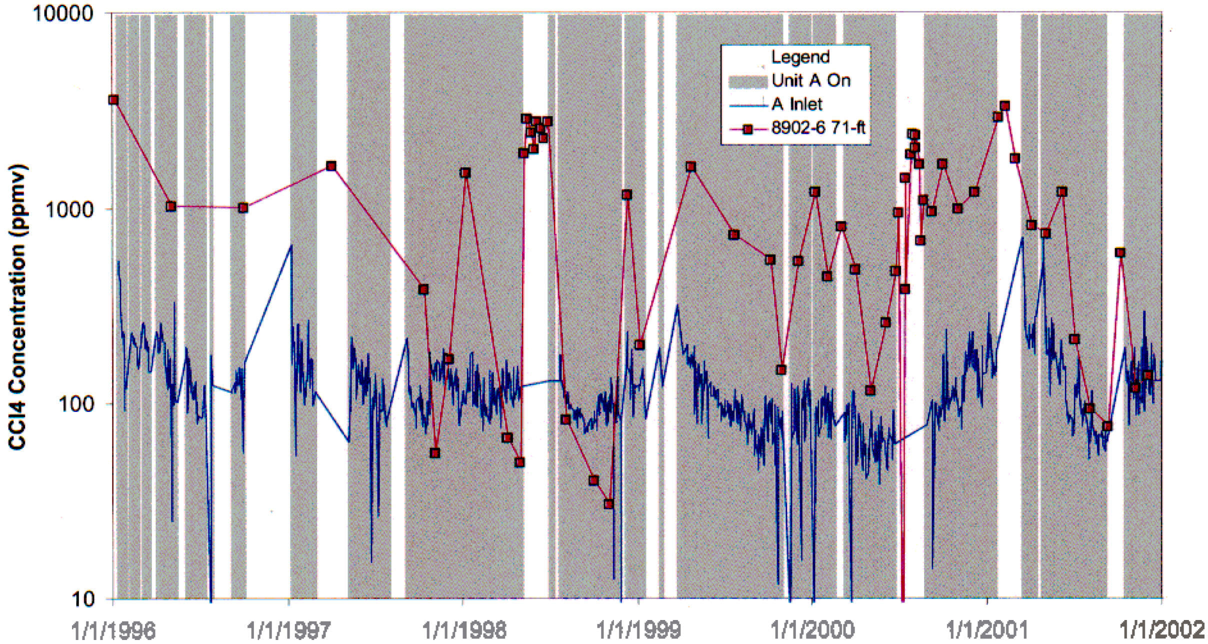

Figure 5-23. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 8901-6.

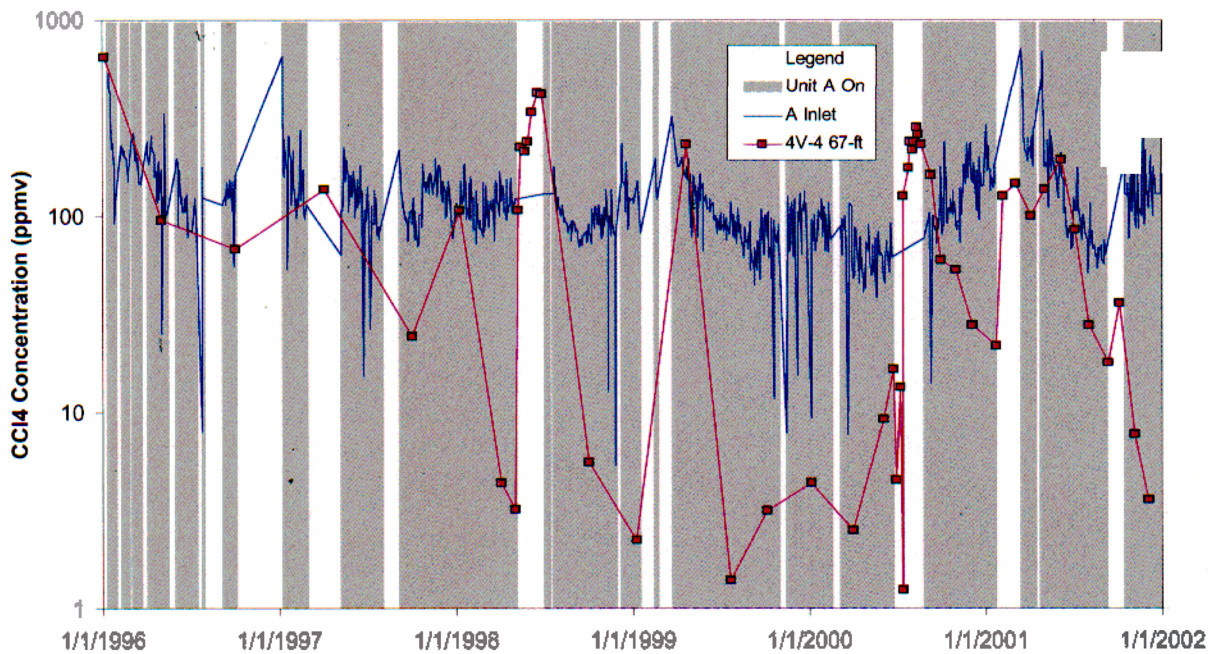

Figure 5-24. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 4V-4.

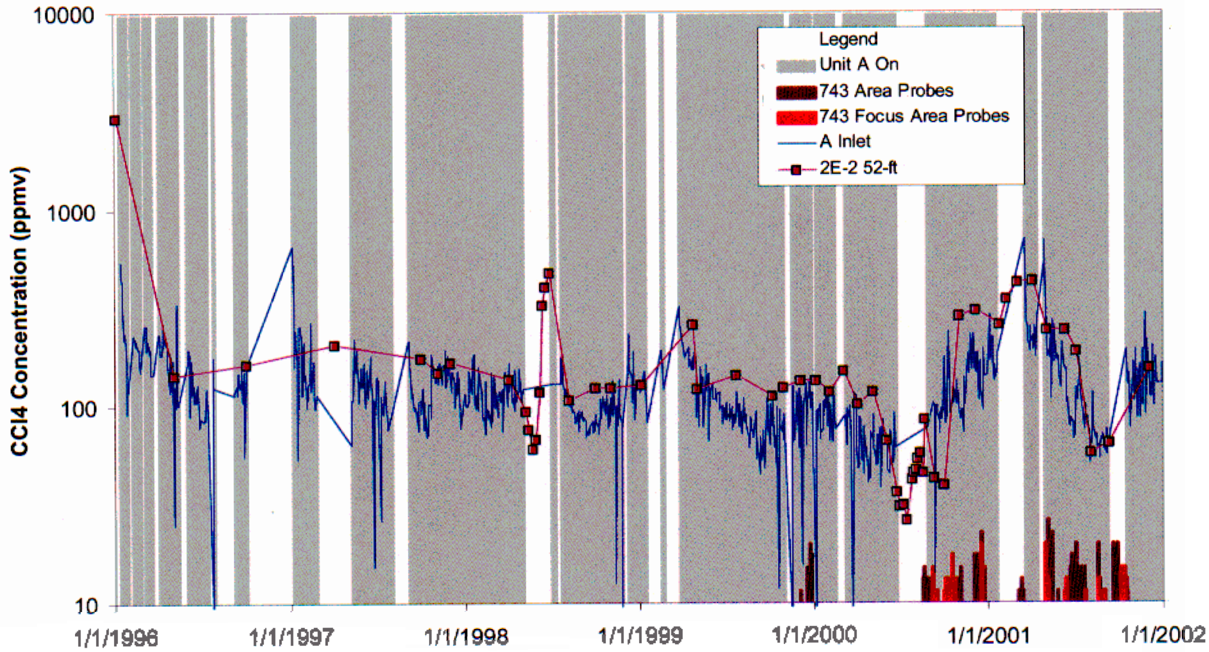

Figure 5-25. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 2E-2.

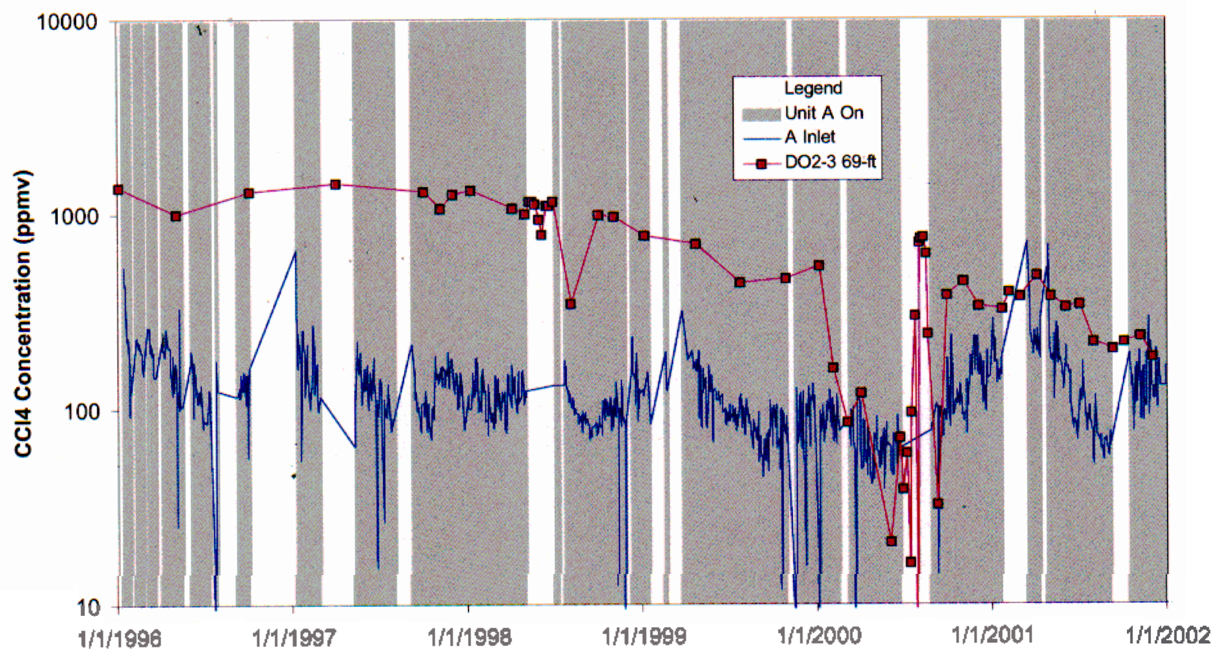

Figure 5-26. Carbon tetrachloride concentration at Unit A inlet and Vapor Port DO2-3.

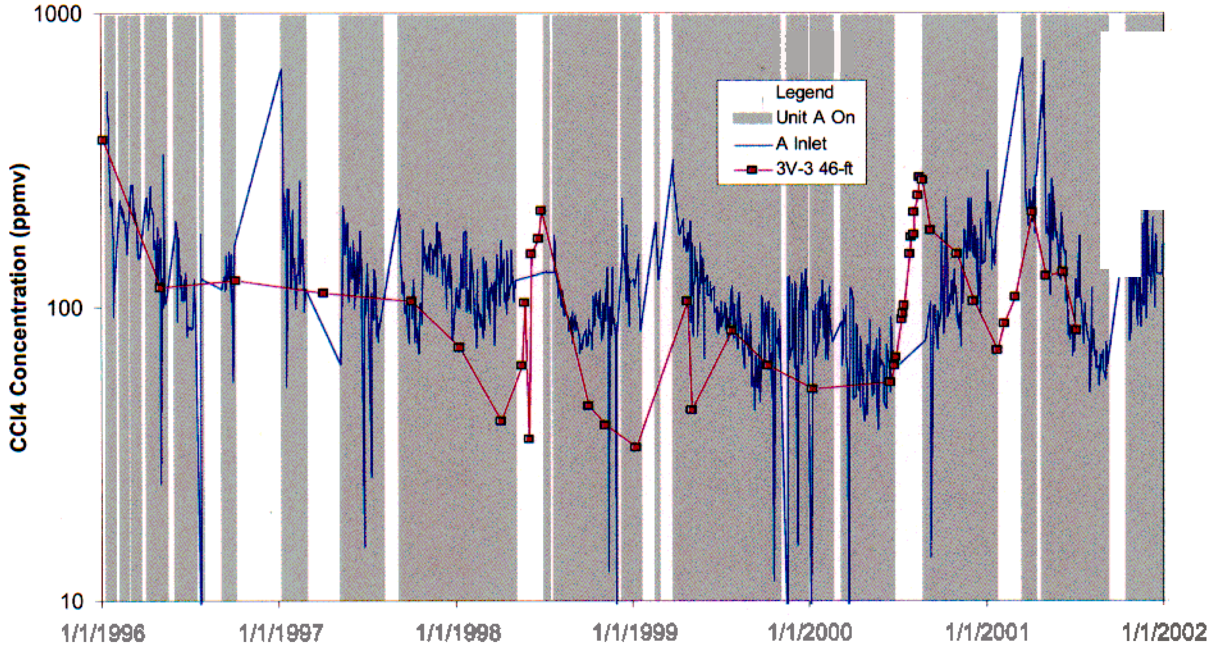

Figure 5-27. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 3V-3.

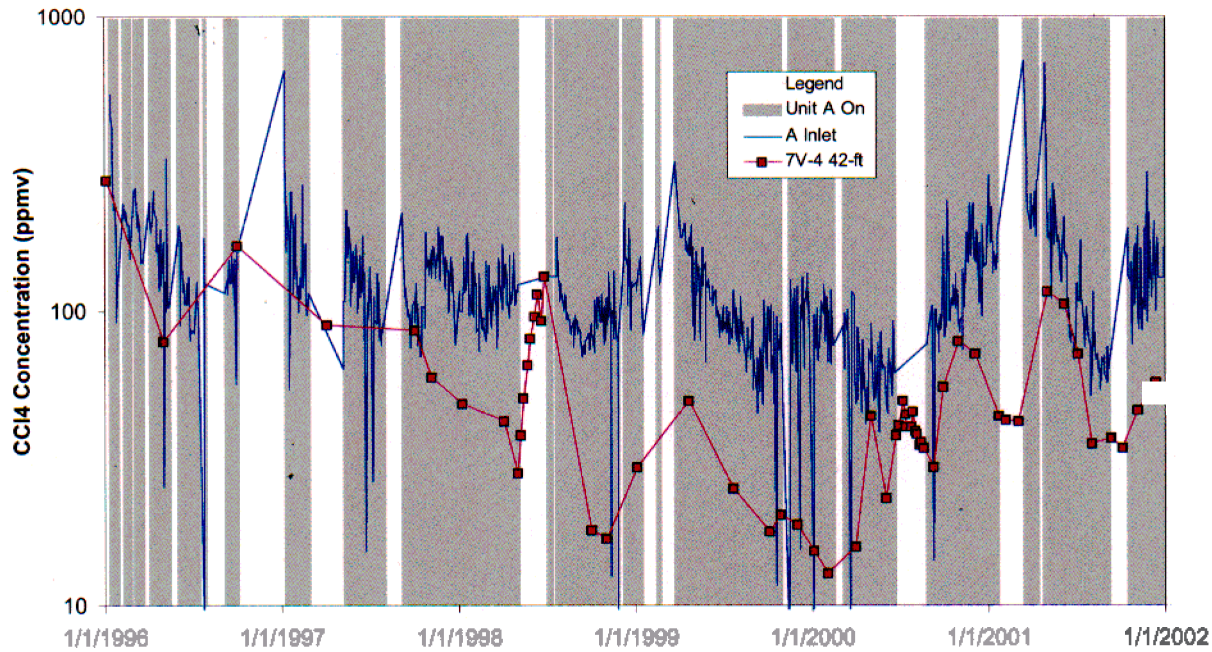

Figure 5-28. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 7V-4

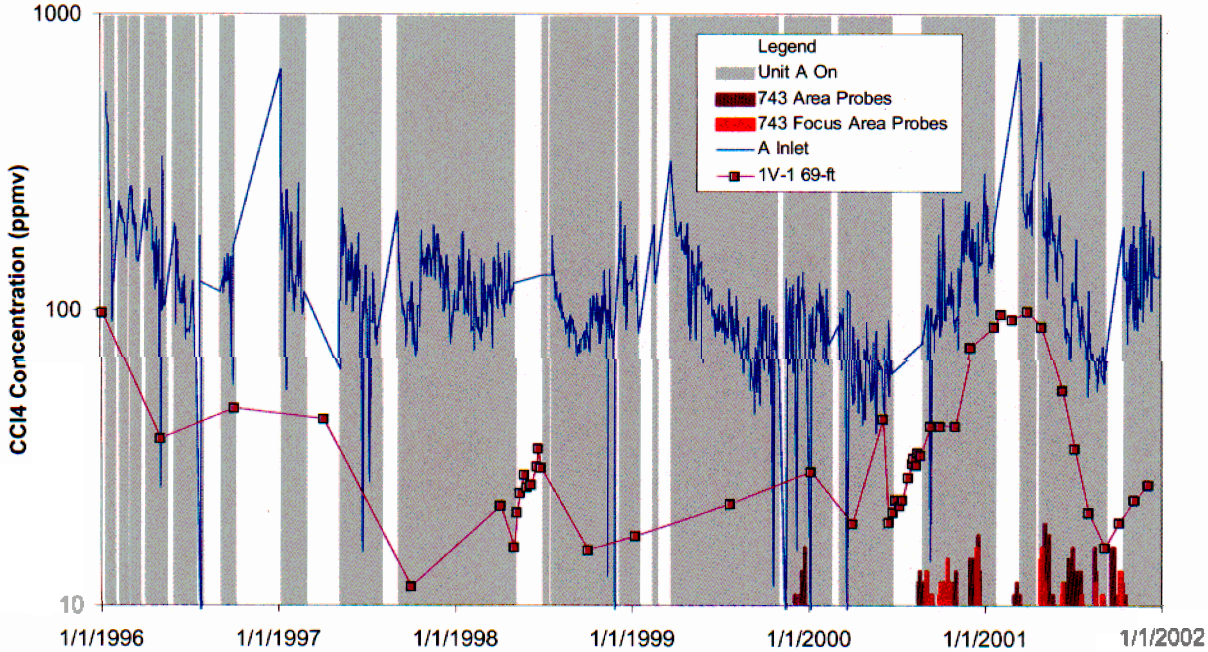

Figure 5-29. Carbon tetrachloride concentration at Unit A inlet and Vapor Port 1V-1.

Table 5-3. Information on vapor ports shown in the figures for Unit A.

Figure	Well or Vapor Port	Depth (ft)	Approximate Distance from Well 8901 (ft)
5-21	9301-4	136	10
5-22	8801-4	78	80
5-23	8902-6	71	160
5-24	4V-4	67	330
5-25	2E-2	52	460
5-26	DO2-3	69	475
5-27	3V-3	46	660
5-28	7V-4	42	1,000 [a]
5-29	1V-1	69	1,350

a. Well 7V was connected to Unit A from September 1997 to September 1999. Otherwise, Well 7V was connected to Unit C.

An indicator that subsurface vapor at a point is being influenced by extraction is that the concentration will go down when the unit is operating and will increase (rebound) when the unit is shutdown. Upon examination of Figures 5-21–5-29, it appears that Unit A may have direct influence on concentrations as far away as 201 m (660 ft) (Well 3V) from Well 8901. In some figures it is difficult to distinguish between the influence of Unit A or Unit B because at times they were both on and off at the same time. However, in 2000 and 2001 when Unit B was off, the concentrations at Well 3V appeared to respond directly to changes in the operation of Unit A. Other wells and locations that respond to Unit A are Wells 9301, 8801, 8902, and 4V. The correlation is less compelling for Wells 2E and DO2, but there are indications that the influence of Unit A extends to those wells also. Concentrations at Well 7V show correlation to Unit A operation but only during the time when Unit A was connected to Well 7V.

The concentrations at some of the vapor ports show a remarkable degree of correlation with inlet concentrations to Unit A. Vapor Ports 9301-4 and 2E-2, Figures 5-21 and 5-25 in particular, track the inlet concentration to Unit A (or vice versa) very closely. Most of the time, it appears that the subsurface concentration responds to unit operation, but at other times, it appears the inlet concentration to Unit A is responding to changes in subsurface concentration. For example, in the latter half of 1998 and 2000, subsurface concentrations went up despite the fact that Unit A was operating. In both these cases, the subsurface concentrations were changing not in response to Unit operation but for some other reason. At those times, the Units were simply parroting the changes. An active source with varying release is the most likely explanation for the changes in subsurface concentration.

An active source, meaning a source that is still releasing mass, is a likely explanation of why concentrations at many locations including Vapor Ports 9301-4 (see Figure 5-21), 8801-4 (see Figure 5-22), and 2E-2 (see Figure 5-25) have an overall flat trend despite being in the zone of influence of the extraction well. During the first year of operations, the concentrations dropped significantly in many of these wells but have changed very little over the past few years.

Another indication of an active source is the concentrations at Vapor Port 1V-1 (see Figure 5-29). Data from this well was shown not because it is influenced by Unit A operations but because the concentration data show an increase coincident with probe installation and similar to the Unit A inlet concentration. Well 1V is over 274 m (900 ft) from the closest extraction well (2E), but it is close to Pit 9, a VOC source area. During the last half of 2000, the concentrations in Port 1V-1 went up dramatically and then came back down in 2001. This type of behavior was seen only in wells near source areas and in the inlet concentration streams. The fact that concentrations came down in 2001 could be that nearly all of the probes installed in Pit 9 were installed in 1999 and 2000. Figure 5-29 shows all the probe installations, but the 2001 installations were in areas other than Pit 9. The possible influence of Unit B operations on Port 1V-1 is discussed in Section 5.3.5.2.

5.3.5.2 Unit B. Figures 5-30 through 5-33 show the concentration at select vapor ports combined with the operational history of Unit B and the Unit B inlet concentration data. Table 5-4 contains the depth of the vapor ports and approximate distance from Well 2E, the primary extraction well for Unit B. From January 1996 until about May 1998, Unit B was connected to both Wells 2E and 3E, but the majority of flow is believed to have come from Well 2E. Video logging and testing performed on Well 3E show that the slots were plugged with a microbial growth.

Table 5-4. Information on vapor ports shown in the figures for Unit B.

Figure	Well or Vapor Port	Depth (ft)	Approximate Distance from Well 2E (ft)
5-30	2E-2	52	0
5-31	3V-3	46	260
5-32	DO2-3[a]	69	450
5-33	1V-1	69	900

a. Well DO2 is approximately 30 m (100 ft) from Well 3E, which was connected to Unit B from January 1996 through May 1998.

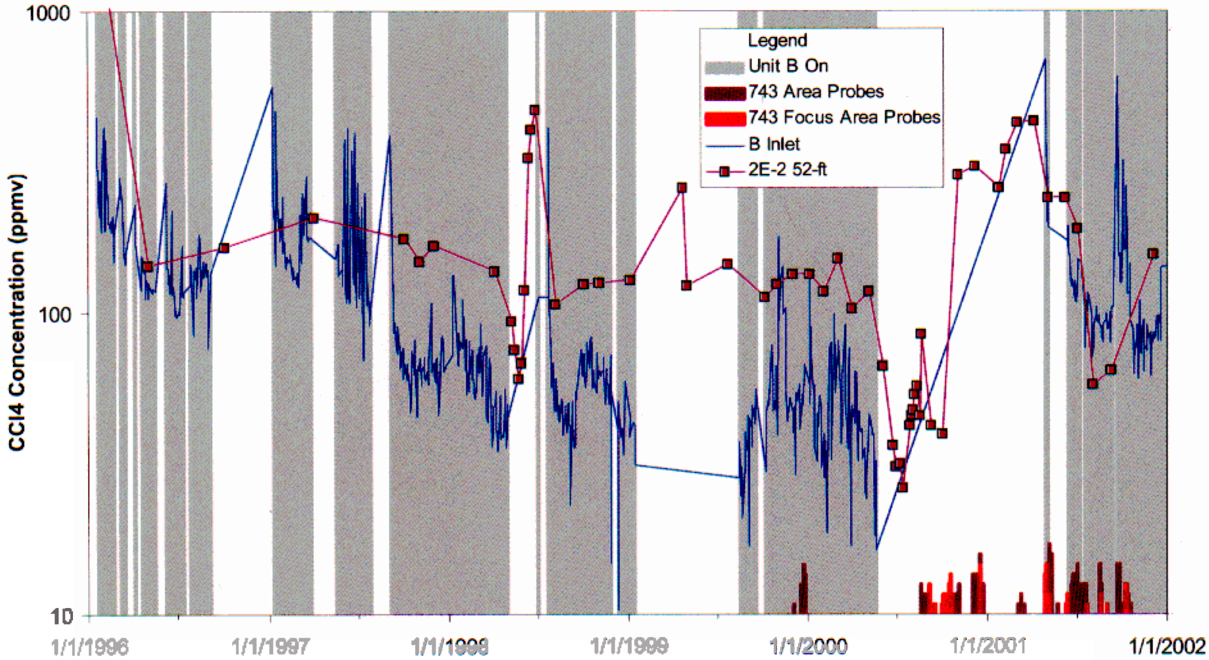

Figure 5-30. Carbon tetrachloride concentration at Unit B inlet and Vapor Port 2E-2.

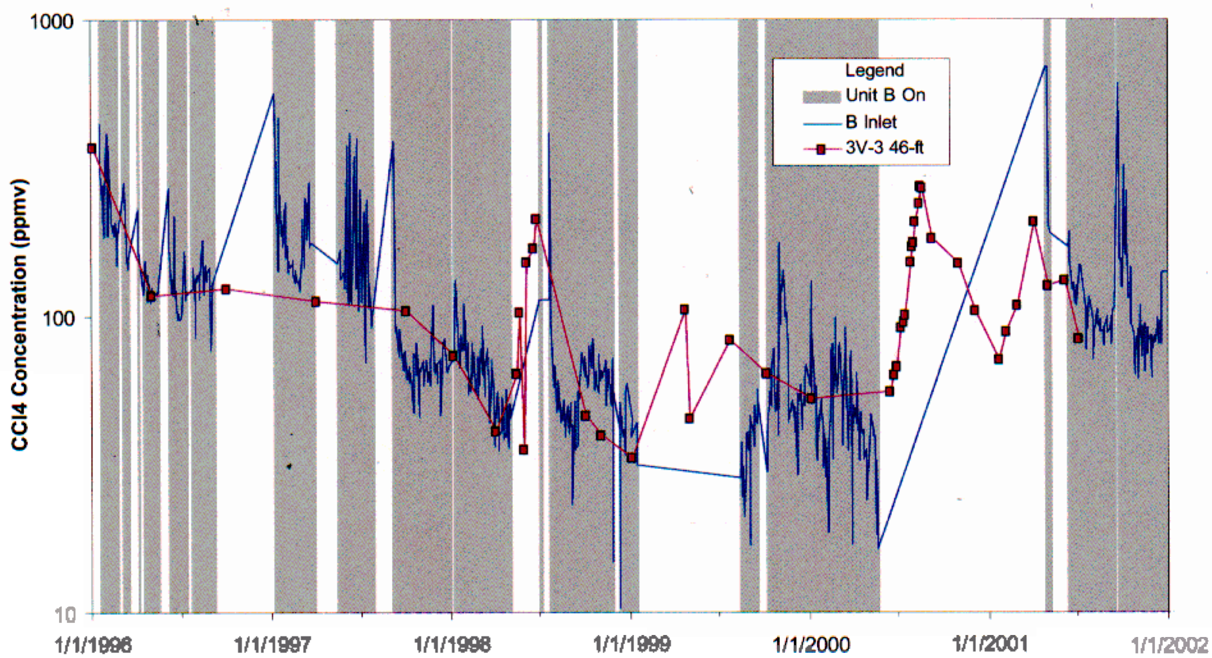

Figure 5-31. Carbon tetrachloride concentration at Unit B inlet and Vapor Port 3V-3.

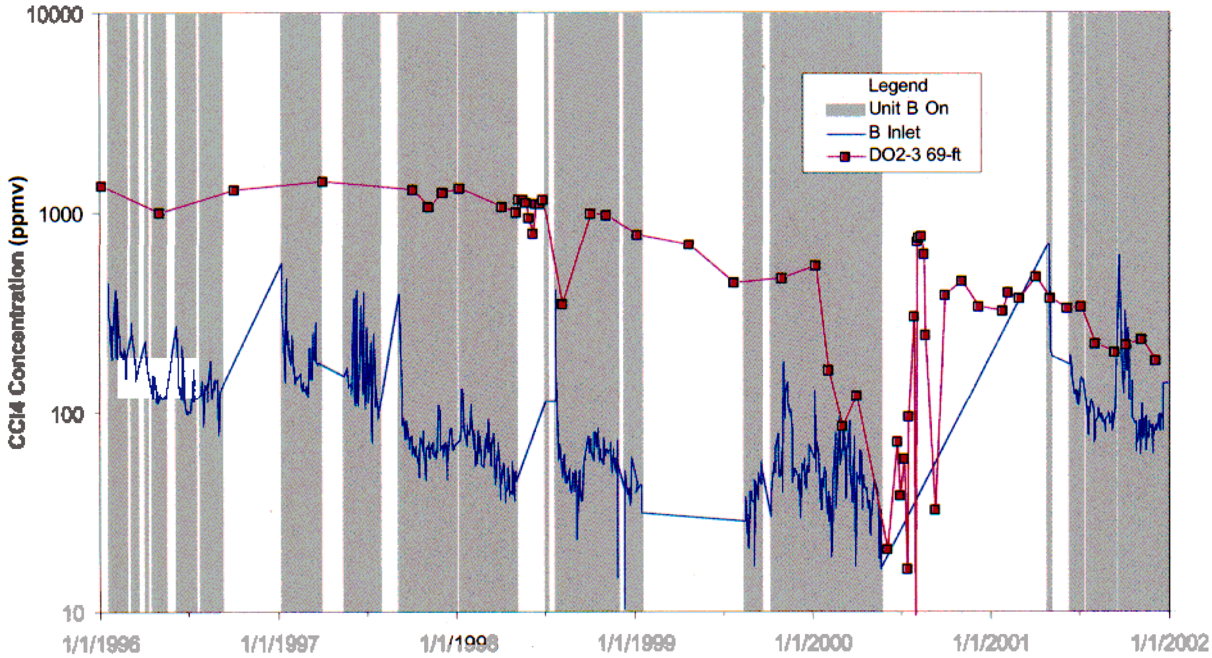

Figure 5-32. Carbon tetrachloride concentration at Unit B inlet and Vapor Port DO2-3.

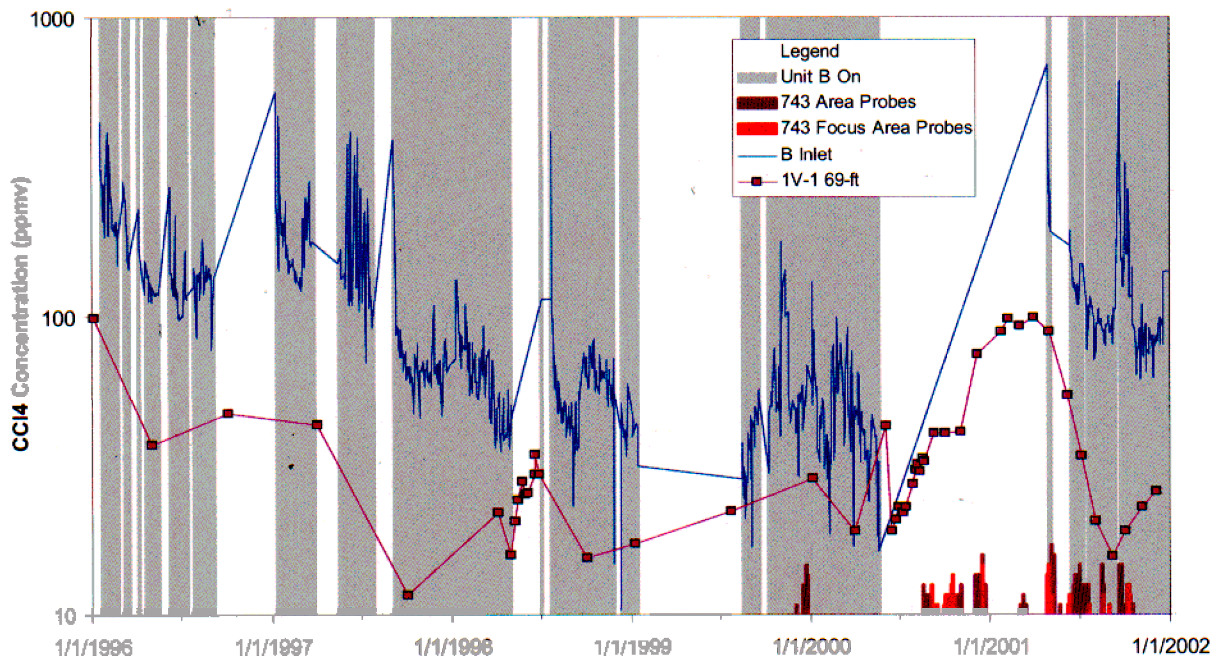

Figure 5-33. Carbon tetrachloride concentration at Unit B inlet and Vapor Port 1V-1.

None of the vapor ports examined, including those shown and not shown in the figures, displayed a clear influence from Unit B other than vapor ports in Well 2E and possibly Well 1V. Concentration data from Vapor Ports 3V-3 (see Figure 5-31) and DO2-3 (see Figure 5-32) could be interpreted as being influenced by Unit B, but this is not definite. While concentrations at these wells and vapor ports may not show direct influence from Unit B operation, it appears that they are being influenced by operations. The concentrations at Vapor Port DO2-3 have been steadily decreasing from greater than 1,000 ppmv before operations to about 300 ppmv, currently. The concentrations at Vapor Port 3V-3 were initially at 300 to 400 ppmv but have been fairly steady at about 100 ppmv for the past few years.

Concentrations at vapor port 1V-1 (see Figure 5-33) indicate possible direct influence by Unit B operations based on the shutdown periods in 1998 and 2000. However, since the probing activity coincided with the long shutdown period of Unit B, it is difficult to say if the increase in concentration at Vapor Port 1V-1 is because of probing-related releases or the result of shutdown and rebound.

5.3.5.3 Units C and D. Figures 5-34 through 5-39 show the concentration at select vapor ports combined with the operational history of Units C and D and the inlet concentration data. Table 5-5 contains the depth of the vapor ports and approximate distance from Well 7V. As previously noted, Well 7V was the sole extraction well for Unit C and is now the sole extraction well for Unit D, which replaced Unit C. In viewing the graphs, it is very important to keep in mind that from September 1997 to September 1999, Well 7V was connected to Unit A while Unit C was being rebuilt.

Table 5-5. Information on vapor ports shown in the figures for Units C and D.

Figure	Well or Vapor Port	Depth (ft)	Approximate Distance from Well 7V (ft)
5-34	7V-1	208	0
5-35	7V-4	42	0
5-36	6V-2	166	400
5-37	8V-3	87	420
5-38	9V-2	157	600
5-39	10V-2	128	1,100

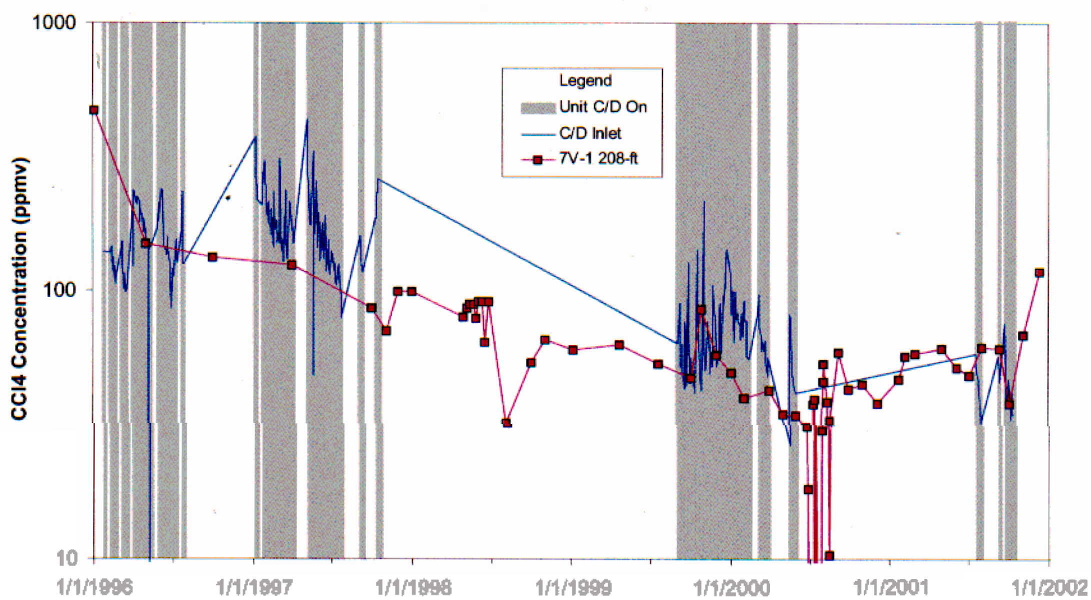

Figure 5-34. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 7V-1.

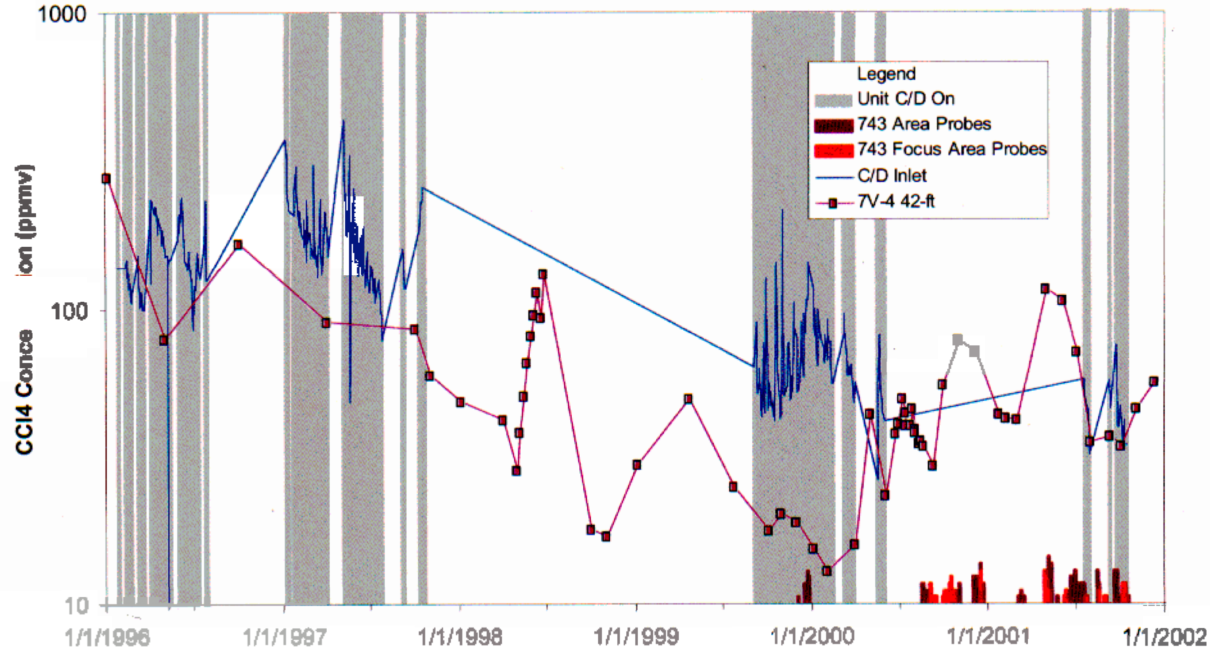

Figure 5-35. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 7V-4.

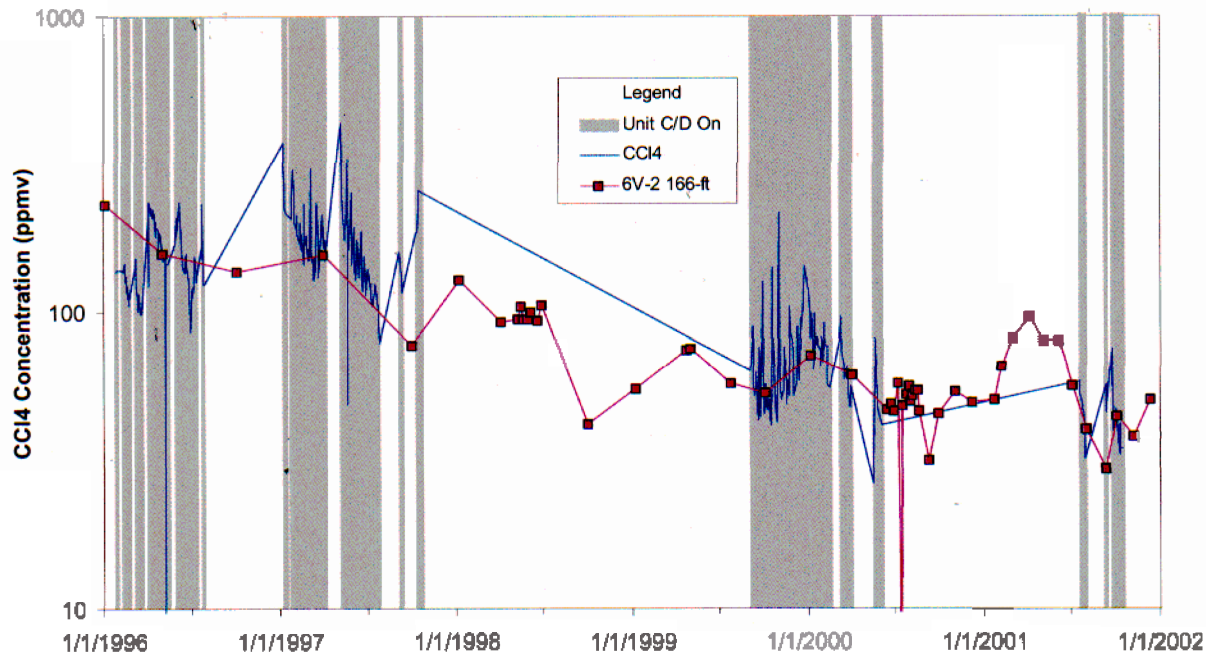

Figure 5-36. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 6V-2.

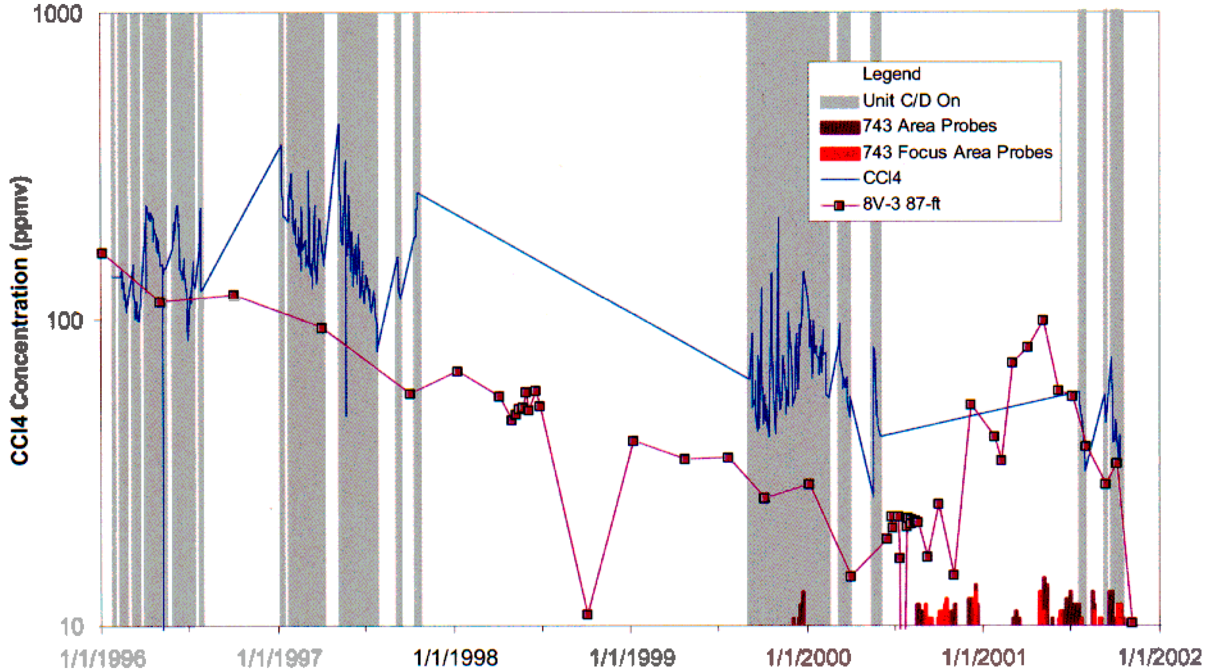

Figure 5-37. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 8V-3.

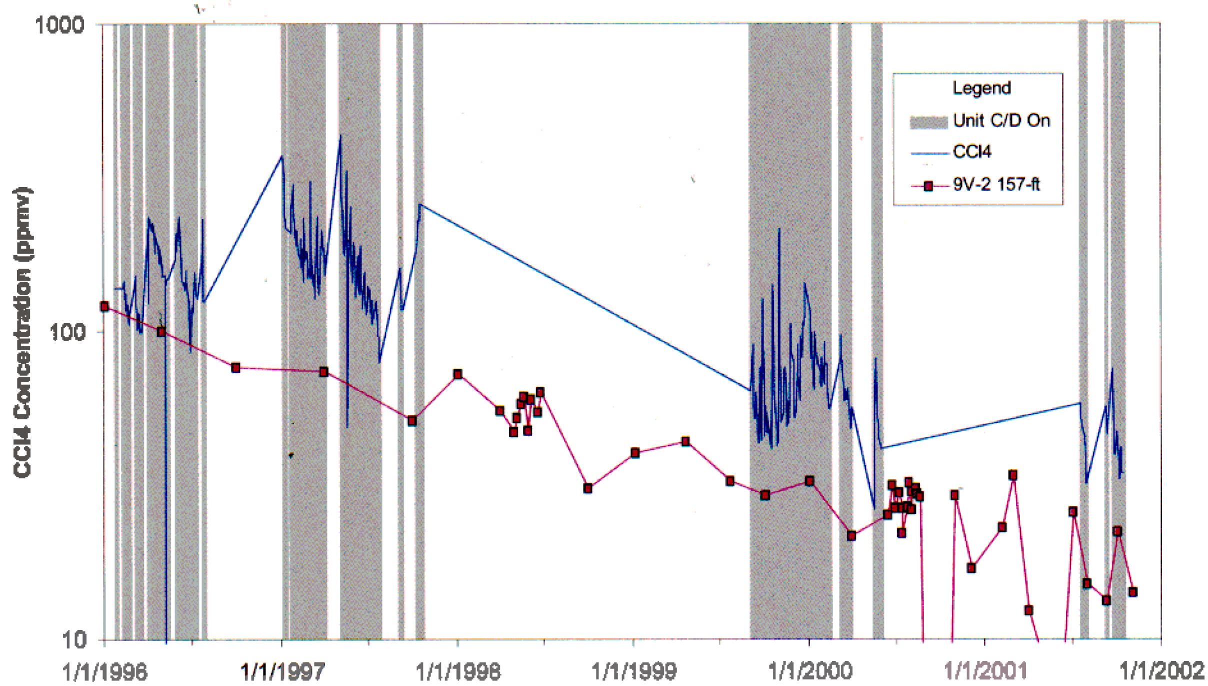

Figure 5-38. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 9V-2.

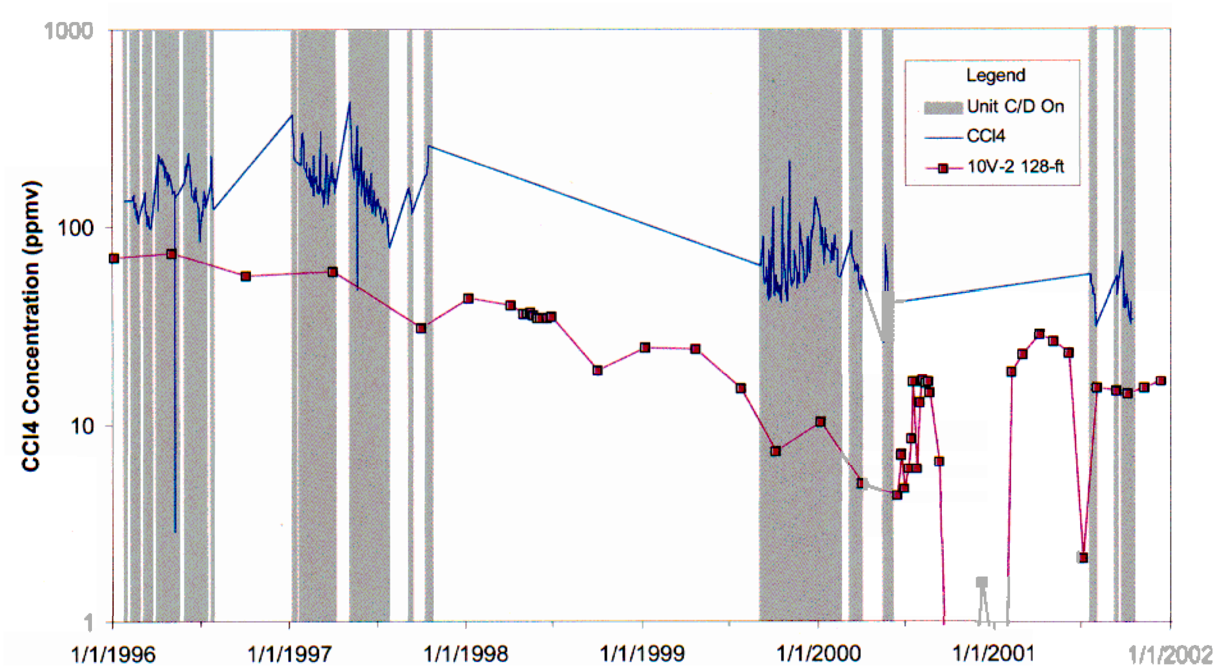

Figure 5-39. Carbon tetrachloride concentration at Units C and D inlet and Vapor Port 10V-2.

Soil-vapor concentrations in the vicinity of Well 7V have declined steadily since the start of operations due, in part, to the connection of Well 7V to Unit A for approximately 2 years in 1998 and 1999 while Unit C was being rebuilt. While Unit C was shutdown and being replaced in 2000 and 2001, concentrations rebounded in several wells and ports. All of the ports shown in Figures 5-34–5-39 indicate some influence, whether direct or indirect, from extraction at Well 7V including Well 10V, which is approximately 335 m (1,100 ft) from Well 7V.

One final observation about the data for Unit C relates to the concentration at Vapor Port 7V-1. Up until this point, any discussion regarding zone of influence has been restricted to horizontal distance from an extraction well with no regard to the vertical component. The extraction zones in Wells 8901 (Unit A), 2E (Unit B), and 7V (Units C and D) are at approximately the 24- to 30-m (80- to 100-ft) depth. Appropriately, most of the influence in neighboring monitoring wells occurs at or around this depth. Stated differently, most changes in concentration, as a result of extraction, occur in vapor ports between 15 and 46 m (50 and 150 ft) below land surface. Concentrations in vapor ports below this depth have not changed much at all as a result of extraction operations with the exception of Vapor Port 7V-1. Figure 5-34 shows the concentrations in Vapor Port 7V-1 (63 m [208 ft] below land surface) have decreased significantly since operations began. Though Well 7V also has a lower extraction screen at about 64 m (210 ft) below land surface, until recently there was a packer in the well to limit extraction from the upper interval. However, this packer was not inflated when last checked, and it is possible that it may not have been inflated for several years. Therefore, it's possible and even likely that Unit C was extracting from the upper and lower screens in Well 7V, and that is why the concentrations at the lower vapor port (7V-1) have decreased so significantly. While Unit D was being installed, the packer was removed from the well after some difficulty. The packer was dropped to the bottom of the well into some mud that had accumulated in the bottom of the well. A video log taken after the packer was retrieved showed the sides of the well were covered with mud. The degree to which the slots in Well 7V may have plugged is not known. Currently, Unit D is connected to Well 7V with no packer, and flow appears to be restricted to approximately 1/2 of the desired flow. The same video log also revealed a break in the casing in the lower part of the well. It is not known how or when the break occurred, but it also could have contributed to extraction from the lower part of the well.

5.4 Evaluation Summary

The VVET system appears to be effective at reducing VOC concentrations in the vadose zone. Data indicate that the extraction wells may directly influence concentrations as far away as 305 m (1,000 ft), if not greater. Though it is likely that the influence is directionally dependent, this was not evaluated. However, from approximately 15 to 46 m (50 to 150 ft) below land surface, the concentrations at nearly every vapor port in the SDA have been reduced from levels measured before remedial operations. Below 46 m (150 ft), there is little if any influence on concentrations at most locations. Even though the extraction wells may have a large horizontal influence, the vertical influence is limited.

While the VVET system is effective and appears to have a fairly large zone of influence, as indicated by vapor port concentrations changing in response to system operation, many vapor ports over the past several years show an overall flat trend in concentrations. Continuous operation may draw down concentrations while the unit is operating, but following shutdown, the concentrations in some wells have rebounded to levels as high as they've been in 5 years. This behavior occurs primarily in wells close to VOC source areas (e.g., Wells 8801, 8902, 9301, 2E, and 7V) and at the inlet to Unit A. In wells removed from VOC source areas (e.g., Wells 6V, 8V, 9V, 10V, and DO2), the concentration appears to be going down consistently with continued operations.

In addition to the flat trends in vapor port and unit inlet concentration data, there are times when the concentration in both the subsurface and unit inlet increases despite continued operations of the units. This indicates that: (1) VOC source areas may still be active and contributing mass to the subsurface, (2) near the source areas, there is still a large reservoir of VOC mass in the subsurface material, or (3) a combination of 1 and 2. If a significant amount of VOC mass remains in the pits, it could act as long-term source, requiring operation of the VVET system for an extended period of time, the length of which depends on the amount of remaining mass and the release rate. In this case, enhanced or accelerated release or removal of the VOC waste may be a worthwhile option because it may substantially reduce operation times.

Because of the existing contamination in the source and subsurface, OU 7-08 will need reliable wells to continue uninterrupted operations. The currently available extraction wells (E and V series wells) are not necessarily in the best locations. Many were drilled as reconnaissance wells and are not necessarily strategically placed for extraction efficiency. In addition, wells of this design (slotted polyvinyl chloride) have shown a propensity to become clogged by a microbial growth (see Section 6.1.6). Wells 3V, 3E, and 4E have all become clogged in the past and are unusable. Efforts to ream out Wells 3V and 4E and make them viable extraction wells were unsuccessful. Well 3E was not reamed because of the lack of success at rehabilitating Wells 3V and 4E. All three wells were tested for adequate flow in 2000, and all three failed. Wells 3E and 3V were retested in 2002, and again, they produced little or no flow.

Currently, there are no good alternatives if Wells 2E (Unit B) and 7V (Unit D) become unusable. Well 7E could be connected to Unit B but will have to be routed around Pad A. It has an open interval from approximately 8 to 24 m (25 to 80 ft) but has not been tested for adequate flow. If Well 7V becomes unusable, the only alternative is to connect Well 8901 to Unit D (305 m [1,000 ft] away). This will leave Unit A without a well, but it could be connected to Well 6E or DE-1. Well 6E is similar to Well 7E in terms of design and has also not been tested for adequate flow. Well DE-1 is open below the C-D interbed (73 m [240 ft]). Additional wells are to be drilled at the end of Fiscal Year (FY) 2002 and in FY 2003. These are discussed in Section 6.

In addition to having reliable wells, the OCVZ Project may benefit from having additional wells available to each VVET unit to be used on a rotating basis. This would allow the VVET units to operate continuously, increasing mass removal efficiency. As the concentration in one well is drawn down, rather than shutting off the unit and waiting for concentrations to rebound, the unit would be switched to a different well where concentrations had rebounded. The wells do not necessarily have to be in different locations. They could be at the same locations but have extraction screens at different depths. Concentrations below 46 m (150 ft) have essentially been unaffected by current operations with the exception of near Well 7V. The feasibility and necessity of deep extraction is discussed in Section 6.